

James Watt

James Watt is best known as the inventor of the steam engine and driver of the Industrial Revolution. This reputation is not entirely deserved, as his invention was actually an improvement on a steam engine invented half a century earlier. Watt was, however, the real inventor of the copying machine.



Steam Engine

James Watt learned the basic principles of instrument-making in his father's workshop. After studying in Glasgow and London, he opened his own workshop at the University of Glasgow in 1757. There he made a variety of instruments, especially compasses and balances. In the years that followed, Watt began to experiment with steam, but was unable to make a working model. Around that time, he discovered that the university had a model of a Newcomen steam engine, which was in London waiting to be repaired.

The Newcomen engine did not work on steam pressure, but on the vacuum created by condensing steam. Watt had the model brought to Glasgow, where he got it running again. Much more importantly, he made an essential improvement that radically reduced the loss of energy. In brief, he added a separate chamber in which the steam condensed, retaining the temperature of the cylinder. In 1769, Watt applied for a patent on "A new invented Method of Lessening the Consumption of Steam and Fuel in Fire Engines."

At first, Watt had difficulty in getting someone to produce his new engine. In 1775, however, his luck changed when Michael Boulton acquired the patent. A year later, the first two "Boulton & Watt" steam engines were in operation, one as a water pump in a coal mine and the other as an air pump for the furnaces of an iron foundry.

In the years that followed, Watt and his colleagues improved the engine on a number of essential points. Fitting a crankshaft, for example, enabled them to transfer the reciprocating motion of the piston into rotational movement. The engine could now be used to process grain or cotton. Watt also modified the design so that the piston was driven alternately by pressure from both sides.

By 1800, Boulton & Watt had supplied some 500 machines. Despite all of Watt's modifications, the efficiency of these engines was never much higher than 2%.

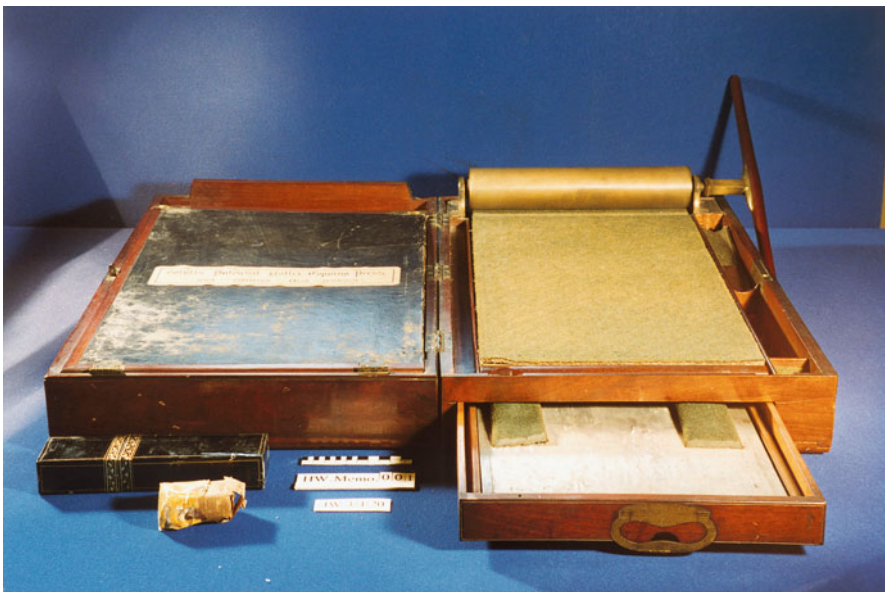


In the course of the nineteenth century, this was gradually increased to around 17% by, for example, using steam under high pressure.

To express the power of his steam engines, Watt invented the term “horsepower,” based on how many horses his clients would save if they purchased one. For many years, horsepower was the international standard unit for measuring power, until it was replaced in 1960 – by the Watt.

Copying Machine

In Redruth, Cornwall, James Watt sat gloomily looking at piles of paperwork. Together with his partner, Michael Boulton, Watt had a flourishing company that supplied steam-driven water pumps to the local mines, where the miners literally worked up to their ankles in water. The orders flooded in. But the downside of their success was the massive volume of paperwork. Letters, detailed construction drawings and bills lay around waiting to be copied. At that time, copying documents was no simple matter. Companies employed clerks to write out the most important documents word for word. Finding suitable clerks was one of Watt’s greatest problems. The mistakes they made copying the documents by hand drove



A portable and collapsible copying machine by James Watt

him to distraction. So he invented a machine that could copy letters and other documents more quickly and accurately.

In 1779, Watt shared his secret with his friend Joseph Black, a Scottish chemist: "I have lately discovered a method of copying writing instantaneously, provided it has been written within twenty-four hours.... It enables me to copy all my business letters." Watt immediately realized the commercial value of his invention, and Black was one of the few to whom he entrusted his secret. Watt and Black were both members of the Lunar Society, a group of prominent scholars in the Birmingham area who met every Monday around Full Moon between 1765 and 1813. Although it was an informal association, the Lunar Society was second only to the Royal Society when it came to scientific influence. Besides Watt and Black, its members included Joseph Priestley, Matthew Boulton, Erasmus Darwin, and Benjamin Franklin, the latter of course corresponding mainly by letter. Their shared goal was to apply science to production, transport, and other social activities. The Lunar Society network was used to bring Watt into contact with a number of prominent figures who would certainly be interested in a copying machine. The widely varying group who did show an interest included economist Adam Smith, author of the classic *The Wealth of Nations*, banker William Forbes, and physician William Cullen, all from Edinburgh.

Watt's invention was based on a relatively simple principle. The original had to be written using a kind of gelatinous ink. It was pressed against the paper on which it was to be copied, which had been slightly moistened, and placed in a press or passed between two rollers. This pressed the ink of the original through the copy paper, rendering the text visible on the other side. Although this was acceptable for correspondence, construction drawings had to be copied onto thick, nontransparent paper. The drawings were then stamped as "REVERSE."

The members of the Lunar Society also helped Watt to solve a number of technical problems. Developing suitable ink, for example, was a time-consuming chemical puzzle. The ink used for the original document had to be thick enough, without smudging. When it came into contact with the moist copying paper, a part of the ink had to be liquid so that it would pass through the paper under pressure, but without running at the edges.

In his patent application, Watt lists the ingredients of the ink, which include mineral water, gum arabic, Aleppo galls, and green vitriol (iron sulfate). Watt's recipe contained more gum and galls than the normal ink of the time. Yet the quality still proved less than optimal and the copies rather pale. On the advice of James Keir, Watt increased the gum and galls even further, which proved to be an improvement on all fronts. The quality of both original and copy was better, and more copies could be made per original.

A year after his letter to Black, Watt was awarded the patent on "A New Method of Copying Letters and Other Writings Expeditiously," after which his copying machine could go into production. The copier was a great success and Watt sold 200 in the first year. The invention soon became popular beyond the borders of Scotland and England. Thomas Jefferson, coauthor of the American Declaration of Independence and third president of the USA, was more aware than most of the



Benjamin Cheverton's machine to copy sculptures, based on a design by James Watt

value of keeping careful records of public documents. He used several versions of Watt's copying machine to do so.

The copying machines were produced by James Watt & Company, in which Keir and Boulton were partners. In the nineteenth century, the machines gradually became a normal office fixture. Alongside standing copiers, James Watt & Company later produced a portable version. In the course of time, more and more versions appeared on the market, some produced by competitors, but for many years it was still only possible to copy "freshly written" documents.

With the invention of carbon paper, especially in combination with the typewriter, Watt's invention gradually receded into the background. Later, the first attempts

were undertaken to make copies using light-sensitive paper, resulting in techniques like blueprinting and the Kodak Photostat machine. The breakthrough to modern photocopying came in 1938, when Chester Carlson invented an easy method of making copies using electrophotography. After his idea had been rejected by some 20 companies, he finally found a partner in 1944 who was prepared to help him develop the technique further. They replaced the term electrophotography with “xerography” and, in 1949, produced the first Xerox.

By the end of the eighteenth century, thanks to the revenue from his patents, James Watt had made his fortune and gradually became less active. But he invented one last copying machine, this time not for anything as simple as paper, but for sculptures. True to his own motto – “what is life without a hobby-horse?” – in his final years, he developed a number of prototypes. There is no exact description of the machine, but the principle was based on a system of parallel hinged arms. On one side, there was a pen which was guided around the contours of the original. The movement was transferred via the parallelogram construction to a rotating cutting element that replicated the original in smaller size in relatively soft material. Although Watt certainly toyed with the idea of patenting the invention, he never perfected it for production during his lifetime. Some 20 years later, sculptor and engineer Benjamin Cheverton completed the design and was awarded the patent in 1844.

References

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